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the republican government should be permanently established throughout the island, we fear it will be the means of checking the internal improvement of the country: for the manners of the republicans have always been more lax than those of the royalists; they have been more insubordinate; they have had less experience of the salutary effect of sage and efficient laws; and above all they have appeared less anxious to diffuse the blessing of education by the liberal endowment of schools, colleges, and other seminaries of instruction. Whatever may be the fate of the island, it must continue to be an object of increasing interest to the citizens of the United States.

ART. VII.—*Geological Essays; or an Inquiry into some of the Geological Phenomena to be found in various parts of America, and elsewhere. By Horace H. Hayden, Esquire.* Baltimore, J. Robinson, 8vo. pp. 412. 1820.

IN the department of natural history, and particularly in the interesting branches of geology and mineralogy, the researches of Americans, if we do not deceive ourselves, have been as profound, and their progress as honourable to the skill and diligence with which these researches have been made, as those of the students of any other country. The numerous and splendid private cabinets, which are to be found in almost every state in the union, displaying not less taste than labour in the selection and arrangement, and the intimate acquaintance of their respective owners with the characters of the various specimens, will sufficiently attest the truth of our assertion. But, until within a few years past, each individual seemed content with the mere possession of this knowledge, without the desire of imparting it to others, or the ambition to be known to the world, as its possessor. The successful labours of Professors Cleaveland and Silliman, of Dr. Bruce, and a few others, have eminently tended, not only to diffuse a spirit of inquiry through our country, and to awaken a fondness for scientific research, but above all to remove that timidity, which has been the chief obstacle to the publication of works of science on the part of our countrymen. The adoption of Professor Cleaveland's elementary treatise, by most of the mineralogical schools of

Germany, where the votaries of natural science have been always numerous and ardent, has been not more honourable to the author, than it will prove, we trust, advantageous to his countrymen. It is at once the noblest reward that he could have received, and the strongest incitement which could have been offered to them. They need no longer withhold from the public the results of their researches, under the fear that they can disclose nothing new. The study of nature can never be exhausted : the various aspects, under which it presents itself, in various countries, and at various times, must always offer to the accurate observer, at every new examination, some fact, some phenomenon, not before known ; and this must always give to the naturalists of this new world a claim to the respect of those of the old. We are anxious to enforce this truth upon our countrymen, and we repeat, that they have a right to claim a higher rank among the philosophers of the earth, than they have been, hitherto, content to hold.

It has been very justly observed by Cuvier, that the ancient history of the globe is one of the most curious subjects that can engage the attention of enlightened men. But it may be doubted, whether, were it even possible to rend the veil which conceals from our view the 'mechanism of the universe,' the human race would gain any thing by the discovery, more than the mere gratification of curiosity. We may admire the genius and the boldness of those who attempt to scan the mysterious operations of Supreme Intelligence, and to explain any phenomenon of nature, by the rules of human philosophy ; but we shall at last be compelled to acknowledge, that the most ingenious theory of creation is but a theory, and liable to be contradicted by facts as powerful as any which are urged in its support. Nor is it necessary to our happiness, to know how the earth we inhabit was formed : whether created as we see it, or changed by subsequent revolutions, or whether these revolutions were produced by intestine fires, or external floods. It is enough for us, to endeavour to become acquainted with the materials that compose it, their relative positions, and the laws by which they are respectively governed. From the prosecution of this study, we not only derive amusement and delight, but acquire a knowledge that may be rendered subservient to the purposes of life. It is an error to suppose, that a knowledge of the antediluvian earth, is necessary to our understanding the relations of its present constituent parts. The first, reason as we may, is founded on, and supported throughout by *conjecture.* The last we acquire by actual experiment and repeated observation. We become acquainted, in fact, with the various properties of minerals, and their relative positions in the earth, *before* we attempt to speculate upon the priority or posteriority of their formation; and thus we gain all the practical advantages to be expected from geological science, without concerning ourselves about the fancied connexion between it and the *cosmogony* of visionary theorists.

The author of the work before us, seems to have been fully aware of these truths; and with the exception of a slight hint at the inadmissibility of either of the two great theories, he leaves the original structure of the globe to bolder inquirers. 'In tracing up in their due order,' says our author, 'all the different formations, and contemplating the varied features that are presented to view, we cannot hesitate long in saying, that great and important changes have been wrought, in and upon its surface, long since the completion of this globe; consequently they are unconnected, and can have no relation with its original formation.' To account for some of these changes, is the limited object of Mr. Hayden's present inquiry. Those which have chiefly occupied his attention, are, 1st, the great *alluvial* district which skirts the Atlantic ocean from the eastern extremity of Maine, to the southern shore of the bay of Mexico; 2d, the formation of *Deltas,* and 3d, the *degradation,* or diminution in the height and bulk of mountains, by the disintegration or decomposition of rocks.

With regard to the first, no naturalist can travel over the North American continent, and fail to observe this striking and peculiar feature in its geology. It has consequently been the subject of much discussion, and of many contradictory opinions; but nothing more than confined and partial accounts of some of its most extraordinary appearances, have ever before been attempted. The most generally received opinion with respect to this alluvial district is, that it has been formed by the retrocession of the sea; many geologists, however, have maintained, that it has been gradually produced by *alluvious depositions* at the mouths of the great rivers which empty themselves into the sea. Mr. Hayden contends, that neither of these causes is adequate to the production of such an effect, or to account for various appearances, which an examination of the district presents. Rejecting both opinions, therefore, and confining himself to a close investigation of *facts*, he supposes that the strongest evidence is afforded, 'of a *general current* having prevailed over the whole of this continent,' and 'that it flowed *from the north-east to the south-west.*' To the operations of this current is ascribed the formation of the alluvial district. We shall endeavour, in the first place, to lay before our readers some of the principal arguments of our author in support of these two propositions, and, in the next place, show his view of the probable causes of the current.

1. Deposites of fossil wood, and animal remains, are found *at* and *below* low water, throughout the whole of this region, which it is evident was once occupied by the sea, because it is formed upon a sea *bottom*, or mud, containing marine shells; and because the remains of sharks and whales are found mixed with those of land animals, not in a petrified state, as in secondary formations, but as in alluvious deposites.

2. Immense quantities of *rolled pebbles* of *primitive* formation are found in the same region, in situations where no other primitive formations exist. Their being found south of the primitive district is a proof, that the current must have flowed from the north.

3. The alluvial region increases in breadth, in the same proportion as the country, over which it is supposed to have flowed, increases in breadth.

4. The high northern regions are, for the most part, destitute of soil, presenting little else but naked, barren rocks. That these rocks were once covered by soil and vegetation, is inferred from the remains of plants and animals, peculiar to the region, being found among the deposites to the south.

5 Rocks of enormous size are found deposited in this alluvial region, at a considerable distance *south* of the primitive formations. Rocks of the same kind are found *en place* in abundance, to the *north;* whereas none of the kind are found south, nearer than beyond the sea.

6. And lastly. The bottom of the ocean, in general, at the depth of seventy fathoms, is found to consist of little more than pure *mud:* the alluvial region, and the sea-shore are of

sand, or pure grains of quartz; this region, therefore, has not been produced by the washings of the sea.

These are facts, which must have fallen under the notice of all, who have taken the trouble to examine the alluvial district along the Atlantic coast; and we regret, that the author should have thought it necessary to produce so much testimony in support of his own affirmation of their existence. The mass of evidence which he has crowded into this part of his work, from other writers, and which, we are convinced, he did rather from a diffidence of his own authority, than from any desire to make a vain display of his reading, answers no other purpose than to obscure the sense of the writer, and to exercise, rather too severely, the patience of the reader. In wading through long quotations to prove the existence of a solitary fact, to which the author's simple assertion would have gained sufficient credit, the reader is apt to lose sight of the hypothesis, which this fact is intended to elucidate. But, we repeat, it is too manifest, that this fault has its origin in a laudable design, to deserve much harshness of censure.

This idea of a general current, so far as it regards its course over this continent, is, we believe, entirely new. Mr. Kirwan, in his attempt to explain the phenomena of the deluge, and to vindicate the Mosaic account of this catastrophe, supposes that the great southern ocean contained sufficient water, *in addition to the forty days' rain*, to inundate the whole earth; and that from this source proceeded, *towards the north*, that rush of waters which overwhelmed the globe. But admitting the plausibility of this hypothesis, it does not account for the current, *from north to south*, over this continent, nor does Mr. Hayden suppose that this current necessarily made a part of the *general* deluge spoken of by Moses. Taking for granted the *possibility* (proofs of any theory would be out of the question) of St. Pierre's notion, that the sun may have deviated from the ecliptic, at some period of the world, and have passed over the poles, he assumes as a natural consequence the dissolution of the polar ices. St. Pierre is not the only philosopher who has maintained, that the axis of the earth has been changed. The opinion, indeed, is now become general; for upon no other hypothesis can numerous natural phenomena be explained. Allowing our author, then, to 'assume the position,' let us see how he contrives to make the melting of the ice at the north pole, a sufficient cause of the effects he has described.

'From this pole, there are but two outlets; the one into the Pacific ocean, through the comparatively narrow channel at Bhering's straits; the other through an immense channel into the Atlantic ocean, between the coast of Greenland, and North cape on the northern coast of Lapland. These two outlets are situated almost diametrically opposite to each other on the two sides of the globe: and whether the sun passed through the meridian of the Atlantic ocean and South sea, as is pretended, or upon a meridian passing through the continent of North and South America, and Asia, is immaterial in the present view, since by far the greatest proportion of the waters must have been thrown into the Atlantic ocean. No sooner was this operation established, and this accession of strength and power thrown into the Atlantic ocean in particular, than its tide began to rise above its common limits, accompanied by a consequent current, both constantly increasing, the one in height, the other in rapidity, proportioned to the increase of power at the focus. These, following the natural course of the Atlantic, soon swelled its waters above the shore of the adjacent continents, over which they began to flow in riotous disorder.

'At the commencement of this frightful drama, it is highly probable that the current, issuing from the pole, was divided by the craggy heights of Spitsbergen, and a part thrown into the White sea; while the other, directing its force against the inhospitable shores of Lapland, and the rocky cliffs of Sweden and Norway, was thrown back upon the eastern and southern coast of Greenland; from thence in a south-western direction, until it struck the south-eastern coast of Labrador, along which it swept, through the straits of Belle Isle, across Newfoundland, Nova Scotia, and along the Atlantic coast into the gulf of Mexico. The rapid dissolution of the ices at the pole constantly *progressing*, and as constantly increasing the rapidity of the current and quantity of water in the ocean, it continued to rise in awful majesty, and threaten universal destruction by its resistless force, sweeping across the neighbouring continents.

'A cursory view, or even a glance at the subject, will enable us to form an idea of the operations that must naturally have occurred, from this new order of things. The current, bursting through each avenue, swept in its course every yielding substance. In a short space of time, the southern and eastern coast of Labrador, over which this current was urged with increasing force, was desolated. The soil, which before had fertilized this rocky coast, was hurled adrift, and mingling with the water, was carried across the country into the gulf of St. Lawrence, and across a part of New England into the sea, or general current of the ocean.

'The waters continuing to rise, soon inundated the frozen regions of Iceland and Greenland, and urging on their precipitous course, swept across Davis' straits, and rolled their tumultuous surges into Hudson's bay, embracing the whole coast of Labrador, while the unequal current of the St. Lawrence was *forced back and upwards to its parent source.*'

If we admit the dissolution of the ice at the north pole, from whatever cause, we may readily admit the whole of the consequences so minutely marked out by Mr. Hayden. But his theory does not suppose an entire dissolution: on the contrary, enormous masses of ice, enclosing huge blocks of granite, must have been torn from their bed by the first violence of the current, and hurled in their solid state, to the regions where this granite is now found, out of place. We confess we cannot understand the necessity of this conclusion. Why is it supposed, that the force of the current was not, in itself, sufficient to transport these masses of granite, without the envelope of ice? For, according to our author's own showing, 'in many places in Baltimore county and elsewhere, during the dreadful fall of rain which was experienced, in almost every part of the United States, in July 1817,' 'veins of granite of many tons' weight were hurried down the streams a quarter of a mile or more, and that almost on a perfect level.' Now the streams in the neighbourhood of Baltimore are all small, and the force of their currents, compared to that which must have swept over the continent by the melting of the polar ices, may be regarded as one to a million; it appears therefore unnecessary to look for any floating medium, to account for the transportation from the north of the large blocks of granite, which are found on the alluvial soil of Ohio, Kentucky, and Alabama. Admitting that these rocks were really brought from distant beds and deposited where they now are, we should regard it as a matter of little importance how they were brought, did not Mr. Hayden seem to lay some stress upon the circumstance of their being 'enveloped in enormous masses of ice,' to prove that they came from the north: 'for it would be absurd in the extreme,' says he, 'to suppose that masses of ice could have been found in the torrid zone, or even within the temperate zone, of sufficient magnitude to have transported those rocks from the south to their present situations.' There seems, besides, to be no little difficulty in the natural inquiries of how, where, and at what period, these rocks were enveloped in the ice? Were they originally formed within the arctic circle? If so, they must have rested upon some solid foundation; and unless we suppose the ice also to have been an original or primitive formation, that must have been formed upon their surface. The ice would necessarily begin to melt from the surface, and the water would continue to run off as the dissolution took place, until the rocks were left bare, or until a liquid ocean only surmounted them. Or if, as frequently happens, large blocks of ice, by whatever cause, should be detached from their bed, and precipitate with them in their fall parts of the rock upon which they rested, the parts so separated, not being enveloped in the ice, would remain upon the spot where they fell, unless urged on by the force of a powerful current *a tergo*. But as the supposed current is produced by the melting of the ice within the circle, its power would be inadequate to such an effect, until arrived at some distance from its source.

There being no force, then, within the space which gave origin to the current, sufficient to propel the rocks thence to the situations in which they are now found, we must suppose that they were not brought from the Arctic region. It is by no means necessary to adopt the reverse of this proposition, and suppose that they came from the south. An immense, unexplored territory intervenes between the commencement of the alluvial district, on this continent, and the frozen regions. The power of an impetuous torrent sweeping over this territory, would be amply sufficient to detach enormous rocks from their primitive beds, and lodge them in distant regions. If masses of ice had any agency in their transportation it must have been by their power of propulsion, and not by serving as a medium in which they could float down the current. Another objection to the idea of the rocks being enveloped in ice, and thus lodged where they are now found, is, that if they had floated with the ice, they would be found much farther south than the latitude of 39° or 40°, 'which,' our author says, 'is about the latitude in which those rocks lie.' For we can hardly agree with him, that, because 'the huge fields and mountains of ice, which every spring float down the Atlantic ocean,' by the time they reach the latitude mentioned, 'become so weak and rotten as to be incapable of supporting or retaining any considerable weight that might be attached to them;' *therefore,* the same thing would occur with the masses of ice, which are supposed to have floated down the current. There certainly can be no comparison between the rapidity of this temporary torrent, and the uniform motion of the Atlantic ocean. A mass of ice would be carried, through the same temperature, to a much greater distance, before it became weak and rotten, down a precipitous *current,* than when slowly wafted upon the bosom of a gentle *tide;* and if by the force of the latter, it yearly reaches the latitude of 40°, we may readily believe it might have been carried to 20° or 15° by the former.

The argument against the possibility of the alluvial district having been formed by deposites from the rivers or the sea, is ingenious and well managed. The author very justly argues, that if this district had been produced by the annual overflowing of the rivers, vegetable remains, and fossil shells, would be found in every stratum, or layer of earth, between the surface, and the depth at which only they are now found. This depth varies, in various parts of the alluvial region; but whether at twenty or at forty feet, no instance has occurred of these deposites, in the intermediate strata. The inference, therefore, seems to be irresistible, that, whatever may have been the cause that buried these remains in their present beds, it operated singly and simultaneously throughout the whole of the region called alluvial.

The next subject treated by the author is the formation of *Deltas.*—The general, and we believe, indeed, the only opinion, which has been hitherto advanced upon this question, is that they are the exclusive production of the *alluvion* periodically brought down by the rivers, and deposited at their mouths. If this opinion were correct; Mr. Hayden very sagaciously infers, that deltas would be formed at the mouths of all the capital rivers, at least of all those 'which bring down an equal quantity of matter of alluvion,' with the rivers at whose mouths deltas are formed. But this is found not to be the fact. 'All capital rivers do not form deltas,' even when they bring down the matter of alluvion in considerable quantities. Hence the author concludes, 'that their formation is not the natural result of the deposition, brought down by their currents, but rather of a combination of causes,' which he thus enumerates, viz. '1st. The alluvion of the river.

2d. That produced by the *winds*, and 3dly, That occasioned directly or indirectly by the *labours of man.*' The principal argument upon which the author rests the establishment of this hypothesis, is drawn from the appearances at the mouth of the Po, and the present situation of the city of Adria. This city, according to the accounts of the best historians, 'was formerly situated on the edge of the coast,' from which it is now distant more than fifteen miles. But in the twelfth century, before which nothing precise, says M. de Prony, is known respecting the situation of the shores of the Adriatic, at the mouths of the Po, the distance of the city from the same coast was but little more than six miles. At this period Mr. Hayden supposes that the city of Adria had been founded for more than three thousand years, making the annual average increase of the delta 'about ten feet and a half.' But to give to our readers a favourable specimen of the author's style and manner, we copy the argument in his own words.

'Let us now examine the rapid increase of the delta at the Po, from the end of the twelfth century to that of the sixteenth, and so on, to see the proportion which the gain of the latter bears to the former, in order to determine whether it has been produced by the alluvion brought down by the current of the river.'

'The northern mouth, which had usurped the situation of the Mazzarno canal, becoming the Ramo di Tramontana, had advanced in the year 1600, to the distance of twenty thousand metres [*something more than twelve miles*] from the meridian of Adria; and the southern mouth, which had taken possession of the canal of Toy, was then seventeen thousand metres (or eighteen thousand five hundred and ninety-one yards) advanced beyond the same point. Thus the shore had become extended, nine or ten thousand metres (or ten thousand nine hundred thirty-six yards,) to the north, and six or seven thousand, to the south. "Between these two mouths there was formerly a bay, or part of the coast less advanced than the rest, called Sacca di Goro. During the same period of four hundred years, previous to the commencement of the 17th century, the *great and extensive embankments of the Po were constructed;* and also, during the same period, the southern slopes of the Alps began to be cultivated."

'From this it appears, that the extension of the delta at the Po had increased, in the space of about four hundred years, nearly eight thousand yards; a distance nearly equal to eight tenths of what it had gained, during the whole period, from the founding of the city of Adria, to the twelfth century: an enormous disproportion, as must be admitted on all hands. But let us examine the subject a little further, in order to comprehend the full extent of this rapid increase.'

The author here quotes a passage from Cuvier, to show that the delta has gained upon the Adriatic, in the last *two* hundred years, about eight miles and a half; and then proceeds, 'almost twice as much as it had gained in the preceding four hundred years, from the end of the twelfth to that of the sixteenth century, and more, (in proportion as eight is to six,) than it had gained from the founding of the city of Adria, to the twelfth century, a period, probably, of about three thousand years.'

'To what shall we attribute this surprising difference, this amazing disproportion? Not, certainly, to the alluvion brought down by the current of the river Po. If its waters had been rendered turbid with mud or alluvion, from one end of the year to the other, for the space of two hundred years, which is a case unheard of or unknown, we could scarcely believe, that it would afford a sufficient quantity to produce that difference; for it must be recollected, that as the delta advances into the Adriatic, or any other sea, the depth of the water is very much increased, and particularly, when we advance to the distance of twenty-one miles from the shore; at least, it is so in most seas.'

The author allows some weight to M. de Prony's opinion, that this increase has been produced by the *cultivation* of the districts bordering on the Po, which prepared the soil to be carried off with greater facility, by the mountain torrents, flowing into the river. But the soil carried down by the torrents alone, he regards as insufficient to account for the increase. Cultivation prepares the soil to be acted upon also by *winds*; the phenomena accompanying the operations of which, he considers as similar to those attending the operations of currents of waters.

'If the *winds* rush, in unsteady and violent gusts, over the land, no matter from what quarter or point of the compass, not only the dust but even the sand is hurled into the air with the same facility as by a current of water, and wafted in clouds over the land, varying on *its* course, until meeting with some obstructions by which *its* current is slackened, *it* immediately deposits *its alluvion*, (for it is nearly the same thing) to the ***leeward*** of whatever object may interrupt *its* course.'

But there is another phenomenon attending the operation of winds, which the author thinks worthy of notice :

'It is, that when a river *running through a country* [where else could it run ?] is confined for any considerable distance from its influx into the sea or bay, between high ridges of hills, or banks, there is a current of wind rushing down its course, differing one or two points from the general course of the wind that may be prevailing at the time, or blowing in nearly a *corresponding* direction [By which, as will be seen, is meant an *opposite* direction.]

'Thus if a river runs in a *southerly* direction, and the wind is blowing fresh from the *north-east*, and raising the dust and sand in its course, when it meets with the current of air flowing down the river, under the circumstances which I have mentioned, the same phenomenon may be observed, as when the rapid currents of two rivers unite ; the sand and dust are whirled round in the most confused manner, and at last let fall upon the shore, and in the water, where, if the tide is setting towards the shore, the sand will be again thrown upon the beach. Hence it is, that we often see narrow projecting points of sand at the mouths of rivers running through a sandy country.'

'The increase of alluvion from this cause, may be thought to be very small indeed ; and as bearing no comparison with that brought down by the current of rivers ; but it must be considered, that a recurrence of this cause may happen every week, or continue for a week. Whereas, rivers seldom bring down much alluvion, except during the heavy autumnal rains, or the melting of the snows in the spring, which rarely occur more than twice in the year.'

The third cause in the combination that produces the formation of deltas, is the agency of man. This may operate either directly, by 'dyking, filling up,' &c. or indirectly, by 'the accumulation of filth and offal from a city, which, when it is a large and populous one, amounts, in the course of a few hundred years, to an inconceivable quantity.' It would be difficult to assign limits to the effects which might be produced, directly and indirectly, by the labours of man. If it be granted to the author, in the first instance, (and the testimony of historians is undoubtedly in his favour) that there was no appearance of a delta, at the mouth of the Po, until after the building of the city of Adria ; and that its subsequent increase was in proportion to the probable increase of population, and the consequent increase of labour ; the justice of his conclusion cannot be denied. Indeed, as the author says, if we examine attentively the nature of these causes, 'we shall not hesitate in acknowledging that they are amply sufficient to effect' all the changes which have been observed, on this part of the Adriatic coast.

With regard to the deltas of the Indus and the Ganges, Mr. Hayden says, 'neither the alluvion brought down by these rivers, nor the labours of man, can be considered in any other light, than as having contributed, *in part,'* to their formation and extension. 'Another more powerful auxiliaary presents itself (says he) as having afforded its constant aid, in the accomplishment of this great work, I mean the great and extensive deserts in the neighbourhood of these rivers.'

> 'If we take into view,' he continues, 'the situation of these barren deserts, rendered still more sterile by the intensity of a vertical sun, that blasts every effort of vegetation upon these oceans of sand; and their exposure to the violence of the eastern Monsoons, which are, for more than half the year, sweeping over these heated wastes, and raising the sand in clouds, and bearing it across the gulf of Scindy, and the mouth of the Indus, need we question the sources from which the materials were derived to form these deltas?'

The author has devoted a separate and entire chapter to the examination of the delta of the Nile, though the greater part of his reasoning upon it might with equal justice have been applied to the formation of deltas in general. His proofs, we think, are abundantly satisfactory, that it is not formed by the alluvion of the river; and the many well authenticated accounts of the desolating effects of the operation of the winds, upon the sandy deserts in its immediate neighborhood, will go far to show, that he has not attributed more to this cause, than it is capable of producing. One of the strongest arguments in favour of the supposed agency of the winds, in forming of this remarkable delta, is that the ancient channel of the Nile, at the foot of the Lybian range of hills, is now entirely filled up; a circumstance which cannot be attributed to the alluvion of the river, because its course being purposely changed by the erection of a strong mound, its waters could have little or no access to it; 'for,' says the author, 'had the waters been suffered to flow through, or over that mound, in any degree, it would ultimately have made a breach through it, and defeated every purpose that was intended.' The inference therefore is, 'that this ancient channel, which stretches along from south to north, on the very borders of the deserts, and exposed to every blast that sweeps over their surfaces, has been filled up by the sands, brought by the winds and deposited in its bed.' The lake Mareotis has been in like manner filled up, 'nearly to the level of the country,' according to Mr. Rennell. If the sands have done so much, why may we not ascribe to the same cause, at least in great part, 'the elevation and extension of the plains of Egypt?' This is the amount of Mr. Hayden's reasoning upon the subject, which is, to say the least of it, as philosophical as that of any of his antagonists.

The formation of the delta of the Mississippi, the author attributes principally to the action of the *general current* before spoken of. We have not leisure to follow him through his arguments, in support of this opinion; if they are not always convincing, it cannot be denied that they are ingenious and novel; and if we do not always agree with him in his inferences, we are compelled to acknowledge that he assumes no unwarrantable premises. We cannot, however, very clearly comprehend the nature of those evils, which he seems so seriously to deprecate, as likely to arise from the increase and extension of deltas, in the neighbourhood of this river. It seems to be the opinion of the author, that the alluvion deposited by the river, at the moment it meets with the resistance of the tide of the sea, into which it flows, will ultimately become an insurmountable barrier; and that the current, thus checked in its advance, will be thrown back upon the country, and destroy it, either by the immediate effects of the inundation, or by the formation of lakes and pools, which, when left to stagnate, will become sources of miasmata, and consequently of deadly disease. Mr. Darby, in his geographical account of Louisiana, expresses the same fear, and the inhabitants themselves are not without apprehension of some dreadful catastrophe, at a future day. But, as there seems to be no evidence, that the Mississippi has ever changed its course; and as, therefore, we may conclude that it has flowed through its present channel, ever since the subsidence of the waters of the general deluge, that is, for more than three thousand years, and that it has 'literally forced its way in defiance of the waters of the gulf and the tides of the sea,' we may reasonably hope, that the dreaded evil of a check sufficient to stop its current and throw it back upon itself, is, if not altogether chimerical, at least too remote to justify the alarm of the present generation.

The third subject of our author, is the *decomposition* of rocks. Upon this, as upon the two subjects just treated of, he entertains an opinion, at variance with the doctrine of most geologists, but certainly more consistent with established facts, and more consonant to the suggestions of sound reason. He does not deny, that rocks are liable to decomposition; but he contends, and we think abundantly proves, that it 'is not a process so general and *so rapid* as many seem disposed to believe.' Among many other ingenious arguments, to show the absurdity of the generally received opinion, we select one, which is in itself enough to decide the question. The agents of decomposition, necessarily acting upon the surfaces of rocks, would first seize upon the prominent points and angles, and show their effects, by reducing these to a rounded appearance. This is the universal effect of the application of the principal agents of their decomposition, or more properly their disintegration, which are, alternate heat and cold, moisture and dryness; and the process of the operation is too obvious to require explanation. This, then, being the fact, and rocks being almost universally found to retain *all their points and angles,* it follows that the process of decomposition has not commenced, or that it is too slow to authorize the prevalent opinion, that 'the greatest part of the substances which constitute most soils proceed from the decomposition of the rocks surrounding or lying under them.' The whole chapter upon this subject is well worthy the attention of those visionary theorists who seem more inclined to create worlds of their own, than patiently to examine the phenomena of that, in which they are placed.

Having thus laid before our readers a view of the principal subjects treated of by Mr. Hayden, it remains only to speak of the manner in which his work has been executed; and here we cannot help regretting, that literature and science do not always maintain that close connexion, which would ensure the mutual esteem and veneration of their respective votaries. The style of this volume will deter many from going through it, who would willingly subscribe to the high claims of the author, as a profound philosopher. It will be seen at once, that Mr. Hayden has been more accustomed to think deeply, than to express his thoughts; and that he has paid much more attention to the *uses*, than to the *graces* of composition. This is not the first time that his name has been before the public. In Professor Cleaveland's admirable work on mineralogy, we find it of frequent recurrence; and this circumstance alone is a passport to our notice. But no one who reads these essays, freed from the trammels of fastidious criticism, will need to be told, that their author merits his respect: whether he had ever heard of him before or not, he would be ready to acknowledge the honour of his acquaintance, after a candid consideration of his claims.

Mr. Hayden's defective style, however, much as it might be censured, is not the greatest fault of his work. It exhibits a want of method and arrangement, altogether inadmissible in a work of science. The chapters, into which it is divided, are without heading; and the divisions are made, in several instances, in the middle of an argument, where the sense would hardly call for a separate paragraph. The chapters from six to eleven, inclusive, should either have been embodied in the first, or have been added as an *appendix*, since the reader is compelled to refer to them, before he can understand the mode of reasoning adopted in the first. The different subjects are mingled together without order, and the necessary consequence is, that the same arguments are frequently repeated.

We have before expressed our disapprobation of the very free use he has made of quotations from other writers. They make up, indeed, so much of the book, that the purchaser may have just cause of complaint, that he has been made to pay, for what was already his own. Nor is he always correct, in his references to the authors of these many quotations. He sometimes gives credit to Mr. Rennell, for the opinions of Herodotus, and to Cuvier, for the sentiments of M. De Prony. But this has undoubtedly arisen from inadvertence, as it is evident Mr. Hayden has studied his subject with too much attention, not to be acquainted with the opinions of all the writers of note, who have touched upon it. Upon the whole, we are disposed to regard the 'Geological Essays' as well deserving an attentive perusal. We would especially recommend the selection of queries embraced in the 'Agenda,' to the notice of every scientific traveller, and man of leisure.